ENGINEERING EDUCATION

Bulletin of the

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:
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VOL. XII LANCASTER, PA., NOVEMBER, 1921 NO. 3

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THE AIMS OF THE SOCIETY.

BY CHAS. F. SCOTT,

President of the Society.

Power has produced a new Epoch:

Power in Production and Transportation underlie the new civilization. It has revolutionized industry, commerce, business, the life of the individual, the stratification of society, the functions of government, and the relations between nations. This is the age of the Engineer.

The pace accelerates.

Quantitatively, the curves of activity are upward; the advance in the past two decades has exceeded that of the preceding century.

Qualitatively, in twenty years new sources of power—the internal combustion engine, the steam turbine, electric transmission—have extended the use of power into new fields; in manufacture and production the engineer deals with more than materials and machinery—his work involves the organization of men, and the efficient use of capital; greatly extended public utilities are engineering services to the community; questions of general policy such as conservation of resources, industrial and social and economic problems, transportation, commerce, both domestic and foreign—all these are the outgrowth of the new conditions which engineering has produced.

Future material prosperity will depend upon the technical ability of the engineer to construct and to operate. Our future well-being will depend upon the solution of the new problems of human relationship.

Training and experience fit the engineer to deal with the industrial, administrative and economic problems and the questions of public policy which engineering activities have produced.

Larger opportunities, wider fields and graver responsibilities await the engineer in the next generation.

Today the future engineer is an engineering student.

Underlying the whole engineering structure lies the training of the engineer. What preparation should he have, what knowledge, what training, what vision, what purpose? How can he be taught, developed and inspired?

These are the problems of the engineering teacher. To their solution the Society for the Promotion of Engineering Education is dedicated —a progressive solution, as progress is forever a process of change.

The Society of Engineering Education faces problems more difficult

and far reaching than the technical problems of the professional societies; the man is greater than the structure; the thinking engineer is greater than the handbook. Its function is to develop teachers who can train engineers.

Every teacher of engineering students should make the problems of engineering training individual and personal; he should realize the significance of engineering in modern life; he should formulate an ideal of what the future engineer must do; he should study how to make his own contact with each student helpful in preparing him for his career; he should seek to combine instruction and training with a personal influence which will strengthen character, inspire vision, and create a sense of the moral responsibility of the engineer in public service. It is not abstract, formal and passive; it is definite, individual and personal. Each teacher must work out his own career. He can do it best in coöperation and counsel with others.

The Society for the Promotion of Engineering Education must employ many activities in meeting its various problems. It must have above all the active participation of all teachers of engineering students and it must receive the coöperation of others—organizations and individuals—who may aid, if it is to fulfill its obligation of support to the engineering profession and of service to society.

In the preparation of the foregoing statement for the Information Booklet various familiar facts assembled themselves in a logical relation which gave me a new realization of the high function of our profession. Perhaps it may lead others to renewed thought on why we teach. Perhaps it may lead others to realize that the vital activity of the Society is that which incites the individual teacher to be a better teacher. Formal conferences with engineering societies and analytical reports of committees may indicate what our product should be and the topics to be taught and the methods and mechanisms which may be used, but the vital force for energizing it all is the personal power of the individual teacher. To directly aid him by association and discussion with his fellow workers is the real purpose of the Branch meetings to be held by the teachers of engineering students in each school. The meetings may consider many topics, but the real measure of success will be determined by the inspiration and insight and enthusiasm they create.

I attended on October 15 the Orono meeting of the New England Section which considered two topics—the teaching of physics to engineers and the proposed new development of the Society. The afternoon discussion on physics was splendid. The objects of teaching physics, the method, the textbooks, the time required, the difficulties encountered—all these were treated by physics teachers and by engineers in a helpful, constructive way. As one of the several professors of physics present told me on the train the next morning, "It was free from hobbies; it was a direct, definite search for information; I was impressed by the serious sentiment of service which prevailed; you seemed to want to train engineers that they may be of real service."

In the evening several men from Tufts spoke of the first Branch meeting at which, in addition to the engineering teachers, there were present representatives from several other departments. The needs of younger instructors were discussed. Dean Anthony said he was surprised to find when he looked at his watch that it was ten-twenty; and there were street corner discussions after we had adjourned. One of the outside professors pronounced it a 100 percent meeting.

I am more and more convinced from these splendid meetings that there is wealth of lively and profitable interest regarding teaching which needs only the opportunity for expression.

The beginning of the year is a busy time, but it is not the time to neglect that most important thing, the purpose and spirit of good teaching. The articles in the October ENGINEERING EDUCATION telling why teachers of English, mathematics, physics, chemistry and economics should belong to the Society indicate the need for Branch meetings for the discussion of how to teach engineering students.

Engineering teaching is on probation. Our Society is meeting a crucial test. Have we the ability as engineers to get at the core of the problem in engineering teaching by an

intensive study on the part of all of the problems we have to meet?

Mr. Hoover, speaking informally at the Engineers Club in New York at a reception tendered to him October 13, said that the way public affairs are conducted is painfully distressing to one having an "engineering type of mind." The habit of ascertaining and agreeing upon facts before discussion and controversy and conclusions is rare. Much of political and industrial and social misunderstanding and agitation could be eliminated by the fact method and yet how little the engineering type of mind has to do with government. How many—if any—engineers have had a commanding place in our political administration between the days of George Washington and Herbert Hoover?

Engineering education has a wider function than training men to build bridges or to produce power. "Engineering is a mode of thinking."

DEVELOPMENT OF SPECIAL COURSES IN ENGLISH FOR ENGINEERING STUDENTS.

BY J. RALEIGH NELSON,

Associate Professor of English, University of Michigan.

The evolution of special courses and in some cases of special departments of English for students in technical schools has been one of the striking developments in the English teaching of the past ten years. In spite of the facetious comments of well meaning but uninformed critics who have jibed at the term "Engineering English" as an anomaly, the movement for specialized teaching of English to technical students has been so earnest an effort to deal intelligently and helpfully with a serious problem that it bids fair to justify itself by the production of encouraging results. These courses have recognized as vital the special interests of the engineering student and his quest for specialized knowledge within a limited field. They have stimulated and encouraged him to write, simply and sincerely, of the things he really loved. When he was only one in a section of literary students, he often suffered the repression of these natural interests; he was forced to simulate enthusiasm, or at least tolerance, for the things which they seemed to enjoy if he wished to escape being regarded as inferior. In fact, because he was different, he often took himself at the estimate of his more literary fellows and admitted that he could not write. In the more congenial association of a group of men with interests like his own, however, he has found the same satisfaction in self-expression that all young, developing creatures do, and has often shown an amazing facility in saying what he had to say.

But these courses have not only opened the dumb lips of our engineering students; they have made possible also a

study of the student himself, his aptitudes, his limitations, his motives, and his needs, as a basis for determining the method of approach. Men with fine pedagogical instincts have been inspired to take their technical students as they found them, and to adapt means for their emancipation to their peculiar characteristics. And since these special courses were thus based on a sympathetic understanding of the student's prejudices and predilections, they have afforded the very best possible opportunity for widening his horizon and making him in the end realize that after all he was destined to be more than an engineer, that he was to be a man, needing a man's sense of his relation to the past of his race, and a man's sense of his right to the rich heritage of its literature. At a time when the demand for technically trained men is so overwhelming, perhaps no greater educational opportunity could present itself than to make these men articulate, and at the same time to help them to appreciate and enjoy the finer things of the spirit so that their necessary contact with natural forces will not wholly destroy their sense of the ideal.

The humanistic values of a subject like English, properly correlated with the technical courses in an engineering curriculum, are so great that one is tempted to expand upon them rather than to address oneself at once to the more concrete problems which confront the educator who attempts to lay aside traditional ideas of English teaching and develop a consistent group of courses adapted to the interests and needs of engineering students. This paper, however, must deal very definitely with practical considerations if it is to be suggestive or helpful. It will aim, therefore, to outline briefly the conditions necessary for the success of such special courses and the ideals which they should embody.

The first condition upon which the success of any experiment with special English courses for engineers depends, is the choice of a satisfactory teaching staff. Granted a coherent, harmonious group of enthusiastic young men interested in the problem, and one may be assured that in one way or

another the experiment will succeed. It should be recognized at the outset that the very highest degree of pedagogical skill is imperative. The members of the English staff should be chosen for their ability and, if possible, for their successful experience as teachers. They should be sympathetic, tactful, enthusiastic. They should possess common sense, balance, poise. Above all, they should be virile, dynamic personalities. Moreover, since the team work of the entire group is in this case so important, their ability to coöperate and merge their individuality in a common cause must also be prerequisite. And background! Nowhere is it more important to get men with a sense of the bigness of the world and the wide sweep of its interests. One should seek for his staff men with sound academic training, men with scholarly ambitions, but men who have also had vital contact with the world. Experience in business or in some form of art, acting, painting, music, or in newspaper or journalistic work is a real asset for a man. By preference I would take a man with an avocation for which he had a real enthusiasm as less liable to become one-sided in the course of a few years' service. And finally, unless a man is interested enough in the problem of teaching English to engineering students to go into it whole-heartedly, I do not want him. If he feels in his secret soul that he would prefer to teach literary students, if he regards his work in the engineering college as a mere stepping-stone to something else, he can not long be useful as a member of an ideal staff. It will be admitted that no staff can be constituted wholly of such paragons of pedagogical virtue as I have outlined, but I have felt it worth while at least to formulate the ideals which should govern the choice of members for such a staff. Success will be largely determined by how nearly such an ideal group is realized.

A second circumstance upon which the successful development of an English curriculum within the engineering college depends, is the assurance of favorable working conditions for the English staff. Indeed, the attraction which such conditions offer is often sufficient to keep men on the

staff who might get higher salaries elsewhere. In the first place, no English teacher should teach more than ten hours a week. That should be the maximum limit. No class should enroll more than twenty-five students. With this merciful limit on the teacher's work should go, however, the requirements that each instructor read all his own papers, and that he give at least eight hours each week to personal consultation with his students. At Michigan the personal consultation of teachers and students has become not only an integral part of our teaching plan but has come to be regarded by both students and instructors as of greater value than the class work itself.

If possible, each instructor should be provided with an individual office, no matter how small, where he can meet his own students without interruption. Years ago I boldly chopped one of my class rooms up into tiny compartments which the facetious have styled my sandwich cars, but which have furnished my men with a perfectly adequate opportunity for consulting with their students alone. I have also found that a little consideration of the instructors' preferences and convenience in the making of my program has helped to get the best work from my men and has not only made them more satisfied but has made it possible for them to do the graduate and other outside work which I think essential to their own development.

But no matter how competent and enthusiastic a staff may be secured nor how favorable the working conditions, no large measure of success can be hoped for without the cooperation of the entire engineering faculty. The English instructors may lay every possible stress on the importance of the English courses, but unless the student hears the same emphasis on their value from his engineering instructors, he is little impressed. Nor do I think the engineering faculty can be expected to lend their coöperation simply as a matter of policy. No perfunctory recommendations will be of much value. The burden of proof lies with the English staff. They must, of course, prove the value of their courses to

both the faculty and students and build up definitely a tradition in the college that English is an important part of the training for the engineering profession. But there should also be developed as soon as possible a consistent emphasis on this fact throughout the faculty.

It should also be recognized that the English faculty alone cannot bear the burden of responsibility for reforming the student's English usage. If the student is to speak and write correctly and accurately, every instructor in the engineering college will need to be alert to his difficulties, and to hold him to a reasonable standard in all written and oral work. A consistent policy and an earnest purpose in this matter would not only reinforce the limited instruction which can be given in the English classes, but would actually do more than any such class work to convince the student that standards of accuracy are demanded as a prerequisite to professional success.

The coöperation of the entire engineering faculty can also do much towards coördinating the English courses with the technical work the student is taking. How perfectly such coördination can be effected is well illustrated by the English instruction at the University of Cincinnati, where the written work done by the students in their technical courses is largely submitted to the English department, for criticism as to form of expression. In my own senior course in Report-Writing, I am succeeding more and more in having the assignments made by the instructors in the technical courses so that a practical coördination is effected between the English and the engineering work the student is taking. When such a coördination is accomplished, the English faculty will no longer feel itself in any sense an adopted child. It will be one of the family.

The conditions, then, which are imperative for the successful development of special English courses in a technical school are the choice of a satisfactory English staff, the assurance of favorable working conditions and the securing of perfect coöperation of the entire English faculty. It

goes without saying, it seems to me, that even with all the prerequisite conditions, the same types of courses might not happen to be worked out in any two schools. The personnel of the English staff, the traditions and background of the students would in the nature of the case differ so widely in different cases that no two English curricula might develop at all along the same lines. Were I to undertake, for example, in any other college the task to which I have devoted the past ten years at Michigan, I am not at all sure that I should care to duplicate any of the courses I have been interested in. There are, however, certain ideal objectives for all such courses that I feel are fundamental here, now everywhere and always. These, I believe, may well be kept in mind.

First and foremost, such courses should aim at discovering the student's real life interest, and life motives, his aptitudes and possibilities for growth. Even though such a research results in the depressing discovery of how limited all these student assets are, it is certainly the point at which one must begin. It is quite as essential to a determination of how to proceed as is the diagnosis in the treatment of a medical case. I have had an interesting opportunity during the past few years to try out the experiment of adapting English teaching to the needs of other groups of technical students than engineers. Even in the case of the dental students with whom we have conducted our experiment now for three years, I have insisted that the same fundamental method of attack be followed. If a man was found who really wanted to write or talk about how a molar or a bicuspid was filled, I have urged my instructors to begin with him right at that particular molar or bicuspid. Of course I have also insisted that if the young dents continued long to discuss fillings and bridges, it was evidence of the instructor's failure to discover the means for enlarging his circle of interests and getting him out of his narrow shell. My observation of the experiment with dental and pharmacy and architectural students, no less than with engineers, leads

me to the conviction that Spencer was quite right when he insisted upon the teacher's beginning with the student where he found him.

The second ideal for the courses in English for technical students should be so to shape the method of the courses that they shall systematically and intelligently make the most of the student's interests and aptitudes. Stimulate the beginning of his development by encouraging him to write and speak of the things which make up the circle of his real interests. Often this is a process of revealing the boy to himself. He is forced to take an account of his stock of ideas and interests in a way that either makes him conscious for the first time of his mental poverty and need, or raises his respect for himself by showing him that the things he knows have value to others. Either of these experiences is often precisely the thing needed to rouse him from his state of mental inertia and marks the beginning of a period of rapid growth.

The third ideal for these courses is to open to the student new fields of interest, to kindle new enthusiasms, to give him a vision of what he may become. When one thinks of what these new interests may mean to these men in years of professional grind, he may well find inspiration for his work in the educational opportunity presented at this point. It must be admitted that the natural effect of the four years' curriculum of engineering studies as they are at present planned is to narrow the student to the intensive study of a few things bearing directly upon his proposed professional career. The danger of such specialization and the need of large, human interests and activities should be constantly pointed out. Perhaps the warning may have greatest weight when given by the instructors in engineering and in technical subjects, but surely nowhere can the antidote be better applied than by a group of enthusiastic English instructors who themselves possess the necessary background and the sympathy to discover sources of appeal to their students. While I do not by any means wish to see the task of humaniz-

ing our engineering curriculum placed on the shoulders of the English department, I do recognize that they have in this particular a large responsibility.

The correction of speech defects and development of the student's ability to talk like an educated man is still another objective which should be consistently kept in mind in all the courses planned for engineering students. The engineer perhaps more than any other type of professional man, unless it be the lawyer or preacher, needs to be able to say what he has to say clearly, forcefully and effectively. I believe the emphasis can hardly be too great upon the oral presentation of ideas. Moreover, when one considers how hampered a professional man is to whom cling the ungrammatical usages of his uneducated parents, no amount of effort to correct these defects should seem too hard a service. It is here that the coöperation of all the engineering faculty is needed. Indeed if it is possible to rouse the student body itself to the necessity of helping each other in this particular, a good speech crusade within the engineering college in which students, English staff and engineering faculty combine to raise the standard of spoken English, can accomplish more than any amount of agonizing over the problem by the English instructors alone.

Still another responsibility is laid upon the shoulders of the English teacher by the fact that the engineering student has less specific training in accurate, organic, analytic thinking, than has the literary student. The English courses are expected to do for the engineering student what all the humanities assay to do in the curriculum of the Literary College. This is, of course, palpably impossible, but every effort should be made to stimulate independent, honest thinking upon vital questions and direct and logical presentation of the real convictions of the students upon the subjects under discussion. The power of logical analysis, the ability to classify, the sense of the importance of organic plan, a feeling for structure—these are all so fundamentally im-

portant for the engineer in so many ways besides his writing that they should be emphasized in all his training.

Last of all, among these ideal aims for these courses is the development in the student of some standards of taste which may serve him in his reading, his theater going and in his observation of artistic performance of various sorts. This sounds so pretentious and is so obviously hopeless in its full significance that I should like to put it somewhat more simply and concretely. Here is a boy—his name is legion—whose real interest in reading is limited to the latest clever story in the *Evening Post*. Now instead of alienating and antagonizing him by scoffing at this popular taste, I encourage him to tell me about it. Then I insist on his deciding exactly why he likes it. That is fundamental. It results in a conscious analysis of his appreciation. Incidentally the first effort to do this in definite form is a rather painful experience and not always productive of satisfactory results. But having helped him to discover the sources of his pleasure, I discuss with him whether it is a sensible and reasonable source of pleasure. If so, I give him another story in which I tell him he will find the same kind of enjoyment. I see to it that this story is enough better in kind to serve my purpose. Then I ask him some such questions as these: Did you like it? Why did you like it? Did you like it as well as the first story of this type you read? Why do you like it better? Is that a sound standard by which to determine the relative excellence of these two stories?

This method applied tactfully but persistently should result in the student's finding a real satisfaction in trying to decide whether a thing is good or bad, and whether it is relatively better or worse than something else of the same sort. Moreover, having found the more abiding satisfaction in the better thing, he loses his taste for the inferior and less artistic performance. In other words, he has begun to develop and use his critical faculties, he has begun to have a standard of taste to apply, and has begun to reach out for

the better things. What such a process of growth successfully started may mean to a boy in years to come it is quite impossible to estimate.

I have felt it advisable in this brief paper not to enter into any detailed discussion of particular courses in English for engineering students. It has seemed better to outline in a broad way the conditions essential for the successful evolution of such courses and the ideals that should determine their method. These are matters of common interest to us all as engineering educators, whether in the field of English teaching or technology. A four-year curriculum of special courses in English which realized the ideals I have enunciated and which were administered under the conditions I have suggested as ideal, should prove a satisfactory means of sending out engineering graduates who would write and speak as educated men are suppose to write and speak.

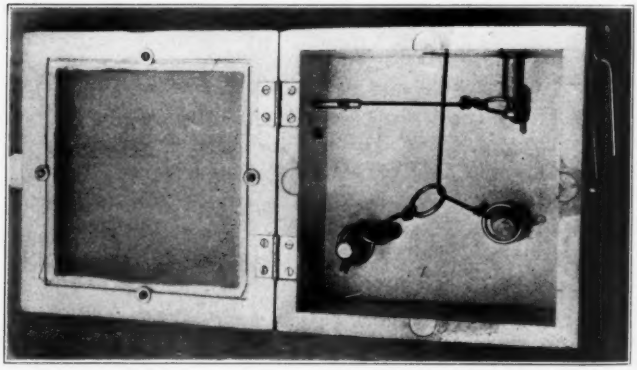
A PROPOSED TEST FOR MECHANICAL ABILITY.

BY ELISE HATT AND G. C. BRANDENBURG,

Purdue University.

Healy's Puzzle Box test for mechanical ability. Directions: "Open this box as quickly as you can. You may use this button hook." When it is open, "Now close it." Note that subject is not told beforehand that he is to close the box.

The purpose of this investigation was threefold: First to attempt to standardize the time element in Dr. Healy's Puzzle Box; second, to discover the nature of the ability it discloses (generally supposed to be mechanical ability); and third, to investigate the correlation of this ability with general intelligence.



As indicated in the picture, the box has a combination lock consisting of a number of rings, staples, and posts connected up in such a manner that except by chance it can only be opened or closed by discovering the proper relation between the various points.

The cut shows the box properly locked except that the

cover is left open. The cover is of glass so that the different parts may be clearly seen by the person working on the box.

The standardization of the Puzzle Box was attempted by determining the time in seconds necessary to open it, and to close it. Data were gathered from the following three sources: first, from a miscellaneous group of students, both sexes, who have come to the psychology department at Purdue for intelligence tests; second, from a group of freshmen boys in a local high school who were simultaneously taking manual training; and third, from two sections of senior engineers who are registered in the Mental Measurements course at Purdue.

TABLE I.

	Number.	Median Seconds to Open.	Median Seconds to Close.	Failure to Close.	Range in Seconds to	
					Open.	Close.
Misc.....	28	120	240	10.7%	45–720	45–1200
H. S.....	18	132	111	55.5%	32–360	35–330*
Senior Eng. .	29	93	98	13.7%	34–311	25–1620

From the above table, the data indicate that the engineers excel both other groups in speed of opening and closing the Puzzle Box; that the miscellaneous group excels the high-school boys in opening, but not in closing. Shall we infer that the high-school boys have in this test more synthetical ability than college students? Now glancing at the number of failures to close in each group, we see that ten high-school boys out of eighteen, or 55 per cent., failed to close the box. Therefore the small number that is left from which to find the median would explain the lowered time of closing, and we would doubt that these fourteen-year-olds possessed as much synthetical ability as the college students.

The performance of certain individuals who took the test indicated its reliability. A girl in the miscellaneous group was fourth in time to open, and she is a successful demon-

* The time was limited to seven minutes in this group.

strator in home economics work. Another, a man in the senior engineer group, who claimed to have been a skilled mechanic before coming to Purdue, held ninth place for speed in opening. The student who held the lowest place in this last group claimed that he had never been able to do mechanical jobs well. (He spoke of this before attempting the test.)

Thus we might say that from individual cases in general the Puzzle Box is a reliable test for mechanical ability. Those who have rated themselves low in mechanical ability seem to be very slow in opening and closing the box.

The miscellaneous group take twice as long to close as to open. This is not true of the engineers, according to the median. By averages, however, the time for closing is increased so that it is almost twice as long as that to open. From these three widely scattered groups a standard time for opening and closing could hardly be set. However, the engineers opened the box in about a minute and a half, while the miscellaneous took two minutes. The high-school boys showed even less speed than this. The senior engineers took about one and two thirds minutes to close, the miscellaneous students, four minutes, and the high-school students almost two minutes. (The fact that only 45 per cent. of these boys managed to close the box because of the time limit set, probably affected this.)

The median in none of these groups can be taken as final. When one is dealing with numbers under a hundred, very little finality can be attached to results obtained from them. Their value lies only in a probable indication of a tendency. All the statements in this paper must be modified in view of this fact.

When the data on the Puzzle Box were collected, an attempt was made to find out what sort of ability the box measured. If it is mechanical ability, what is mechanical ability? There was little information in educational literature on this subject, so the only means at hand was resorted

to, the questionnaire. Obviously the men who would be most capable of defining mechanical ability would be engineers, so we asked for a definition from each of the thirty-eight engineering seniors registered in the Mental Measurements course, and from nine professors in mechanical and electrical engineering.

A composite definition was made from their definitions in the following manner: each definition was analyzed into its elements and these elements tabulated. For instance, the following statement of a Senior was broken up.

"Mechanical ability is a natural aptitude to understand machines and mechanical processes at a glance."

"Natural" implies that this ability is inborn, so we put down *innate*, and checked it once. "Understand" means probably "analyzed," so we check *ability to analyze.*

Similarly, a professor's definition was dissected.

"Mechanical ability is (*a*) that capacity which one has for seeing through any mechanism, (*b*) the ability to construct a working machine or mechanism."

The idea in (*a*) is again that of analytical ability. *Ability to analyze* now has two checks. (*b*) Implies constructive ability, so we check *ability to synthesize.* Every definition handed in was thus divided into its component parts and the points included in the definition are those mentioned by at least eight persons. Analytical ability was mentioned by twenty-six, hand skill, by seventeen. The final definition is not entirely satisfactory and must be regarded as only a tentative form which has served as a working basis for our subsequent study.

Mechanical ability is an innate readiness of thought and hand in analyzing and constructing processes and devices whose parts are related in a logical and more or less complicated way.

Since the more complex mechanical ability depends on the simpler manual dexterity (implied in the definition) the high-school students were given a nail-driving test. That

is, they were asked to drive in five three-inch nails into the top of a thick pine box, with a sixteen-ounce hammer, and time and accuracy were measured. Accuracy was derived from the degree of deviation that the nail took from the perpendicular. This varied from 0 to 80 degrees, and the average of the five nails was found for each boy.

This test was not successful because the differences between individuals were too slight. Evidently the test was too easy. The correlations were as follows:

Time and accuracy with manual training grade	.21
Time and accuracy with time for opening Puzzle Box plus closing	.26

We do not take these correlations as indicative in any way. (Note: all correlations in this paper figured by foot-rule method.)

After we had given the Puzzle Box test to the class of high-school freshmen, and compared the performance with the grades they had received in manual training, we found the following almost negligible correlation to exist between time of opening and grades, .04. The grades compared with closing the Puzzle Box gave a correlation of .17. These very low correlations may not be a true indication of the relation of the opening of the Puzzle Box to ability in manual training for two reasons: first, the grade of the first month's work in any subject would scarcely be an indication of a pupil's ability; and second, the grades in this group were not in accordance with the normal curve of distribution, as there were none in the 90–100 class, and only two in the failing class.

A more extensive study of the relation of the Puzzle Box performance to excellence in shop work was made with the third group, the senior engineers. This study is perhaps the more reliable of the two because the possibility of getting an indication of their mechanical ability was greater. Everyone of these students has had six semesters of shop work: wood, foundry, pattern-making, forging, bench, and

machine tool work in metals, and practice in building complete machines and appliances.

The grades in Purdue are as follows:

A	99 — 90	Passing grades.
B	89 — 80	
P	79 — 70	
C	69 — 60	Condition.
D	59 — 0	Repetition of course required.

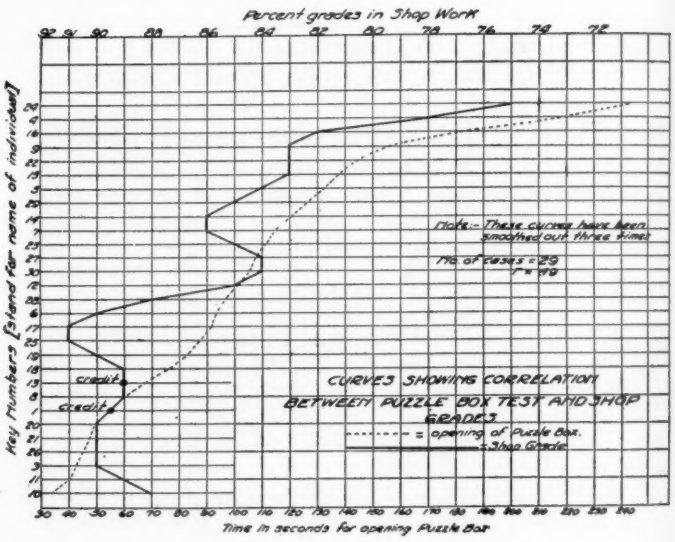
In shop work a D is impossible to get because the completion of the work is the most necessary factor, and a C is given for incomplete work only. Upon completion of the prescribed amount of work, a student is given one of the three passing grades. Only one student in the group had a C, and he had credit for all the other five courses.

The average of their grades in these six courses was compared with the time it took them to close the Puzzle Box, and the numerical correlation was .17, the same as in the high-school group. The time of opening, however, correlated with shop grades was .49, which indicates, according to Rugg, a marked correlation.

The following graph (Diagram I) gives an idea of how close this correlation is. We can see from this diagram that the factors entering into success in shop work seem to a great extent to include quite a number of those making for speed opening the box. The fact that only three grades in Purdue are passing leaves a rather narrow range of differences in grading, and thus the differences between individuals do not show up. Also the small number of students concerned in this group make any inference applicable to only special, similar cases.

Our next effort was to discover, that if the times for opening were arranged in groups of percentiles, what arrangement the shop grades would take in relation to these classes. The percentiles are as follows:

Class I, those who fell in the best 6.9 per cent.
Class II, those who fell in the next 17.2 per cent.
Class III, those who fell in the next 51.7 per cent.
Class IV, those who fell in the next 17.2 per cent.
Class V, those who fell in the lowest 6.9 per cent.


Percent grades in Shop Work
Key Numbers [Stand for name of individual]
Time in seconds for opening Puzzle Box
credit
credit
Note:- These curves have been smoothed out three times
No. of cases = 29
P.E. = 9.9
CURVES SHOWING CORRELATION BETWEEN PUZZLE BOX TEST AND SHOP GRADES
= opening of Puzzle Box.
= Shop Grade

The following tables give an idea of how these arrangements occurred. Table II was prepared by figuring the per cent. of A's, B's, P's, and C's as they fell in the different classes. The A's were counted separately, *i.e.*, each person has six marks (except where credit has been given for work done in other schools, or outside, in which case no grade is given), and the total of A's in all classes was found and the percentage contained in class were so distributed. For instance, Class I has, out of twelve marks, seven A's, 10.1 per cent. of the total A's in all the classes. Similarly, Class I has three B's, 5.88 per cent. of all the B's in all the classes.

TABLE II.

	I.	II.	III.	IV.	V.	Total.
Number of students	2	5	15	5	2	29
Per cent. of students	6.9	17.2	51.7	17.2	6.9	99.9
Per cent. of A grades	10.1	21.7	53.6	11.6	2.9	99.9
Per cent. of B grades	5.88	13.72	51.0	23.52	5.89	100.01
Per cent. of P grades	8.3	00.0	50.0	37.5	4.1	99.9
Per cent. of C grades	00.0	00.0	00.0	00.0	100.0	100.0

This table shows that in the highest 6.9 per cent. or Class I there is a greater per cent. of A's than any other mark. This is true for Classes II and III, also. In Class IV the A's are less than the B's, the B's less than the P's, and in Class V there are more A's than B's, and more B's than P's, but more C's than any other mark. However, since only one C was found in this group, this C class may be ignored.

Therefore it would seem that if a student fell in Classes IV or V he would be more likely to get the lowest mark than the highest. If he opened the Box so as to fall in Classes I, II, or III, he would be more likely to get an A than a P. These statements are not general and no exact prophecy as to success in shop work could be made from them. However, from the general trend of the figures one could expect to find a student falling in Class I to have a better chance of getting an A than any other mark, as would also be true of Classes II and III (although it would be an even chance here that he might get any of the other two marks), and in Classes IV and V, a better chance of getting a P than any other mark.

TABLE III.

Classes.	No. Marks.	Distribution of Grades in Per Cents.				
		A.	B.	P.	C.	
I	12	58	25	17	0	100
II	22	68	32	0	0	100
III	75	49	35	16	0	100
IV	29	27	41	32	0	100
V	7	29	43	14	14	100
Total	145	47	35.5	17	.5	100

Table III was prepared by grouping the number of marks occurring in each class in opening the Puzzle Box, and then separating these marks in percentage groups. For instance, in Class I, in which there are two students, there are six marks for each course in shop work for each student, or twelve marks in all. Out of these twelve, 58 per cent. were A's, 25 per cent. B's, 17 per cent. P's, and so on. There are five students in Class II, hence one would expect to find thirty marks. But in some cases where students have transferred from other schools, or had had practical experience in certain kinds of shop work, they were given credit for the course, without any special grade being assigned to them. Consequently these "credit" marks had to be excluded in figuring percentages. In Class II, then, there are twenty-two marks instead of thirty, and from this number 68 per cent. are A's, 32 per cent. B's, 16 per cent. P's, and so on.

This table leads one to believe that there is a decreasing possibility for obtaining A's in passing from Class I to Class V, and an increasing possibility for getting B's in passing from Class I to Class V. The trend of the figures in the P column is not determined but might indicate the greater possibility of getting P's if one is in Classes IV or V than if in Classes I to III. As before, the C column shows Class V to possess the only C, which in itself is scarcely indicative of any special trend but might in general be said to show that falling in Class V increases the possibility of a C grade. (The registrar's office does not explain why this C was never changed to a passing mark upon completion of work. This student, by the way, is the same who got the lowest rating in speed of opening the Puzzle Box, and who admitted he was poor in shop work.)

The tables are interesting in that they show the possibility of a fairly accurate prophecy of success in shop work, but cannot be taken as at all conclusive because of the small numbers involved. Indeed this objection holds true in all of the work contained in this paper.

Diagram II was constructed by dividing a rectangle repre-

senting the amount of shop work done by the twenty-nine engineering students into the percentile divisions as explained above, making five classes in all. Then on the mid line of each of the five divisions the per cent. or distribution of the marks, A, B, P, and C, were marked off. A curve was made connecting the A point of each of the classes, another connecting the B's and so on. These curves then divided the rectangle into four separate areas, that occupied by the A's, that by the B's, by the P's, and by the C. It can be seen from the diagram that

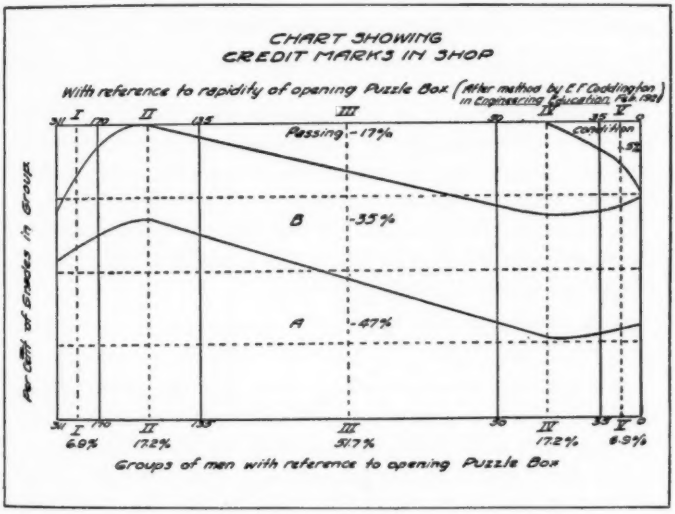


CHART SHOWING
CREDIT MARKS IN SHOP
With reference to rapidity of opening Puzzle Box (After method by E.F. Coddington in Engineering Education, Feb. 1911)
Passing - 17%
B - 35%
A - 47%
Per Cent. of Grades in Groups
Groups of men with reference to opening Puzzle Box

DIAGRAM II.

the A's predominate, that they occupy the largest area, 47 per cent. of the whole. The B's come next with 35.5 per cent. of the total, the P's 17 per cent., and the C a very small area, one-half of 1 per cent. Of course it must be recalled that each of the A's does not stand for one person's average, but is merely a part of the total marks received by the whole group. (Herein this chart differs from Professor Coddington's.)

The straight lines beginning with the middle of Group IV and ending with the middle of Group I indicate the tendency for the quantity of A's to increase as individuals pass from Class IV to Class II, and the same with B. Inversely, the quantity of P's decreases in passing from Class IV to II. This last is true also as regards the C. However, if the correlation were true for all five classes, which it is not, then curves would not, as they do, turn down at the left extremity, but up, and not up at the right extremity, but down. Therefore from data included here, it could not be said unreservedly that it is the tendency for A's to increase passing from Class V to Class I, nor for P's to decrease passing from Class V to I. This holds true only in part.

We were interested in investigating what relation existed between general intelligence and mechanical ability, so correlation of general intelligence tests and time for opening and closing the Puzzle Box were made.

The miscellaneous students all had been given the Stanford Revision of the Binet tests and I. Q.'s established. We found the following correlations to exist:

Time for opening and I. Q.	.28
Time for closing and I. Q.	.32

This indicates that mechanical ability depends only slightly on intelligence. It is interesting to note that in the high-school group as well as in the miscellaneous group, the coefficient for closing was higher than that for opening. The synthetical process seems to bear more on intelligence than does the analytical. This seems logical, as most building up processes (in chemistry, for example) are more difficult than tearing down ones. Further substantiation of this point must, however, be made.

The following graph (Diagram III) gives an idea of the intelligence quotients with reference to time for opening and closing the Puzzle Box. The same trend as expressed above is shown, viz., that there is little correlation between intelligence and mechanical ability, although more between closing and intelligence than opening and intelligence.

The median reached in this test was 109, exactly 9 points higher than the average for the Terman test, and thus the group is well above the median.

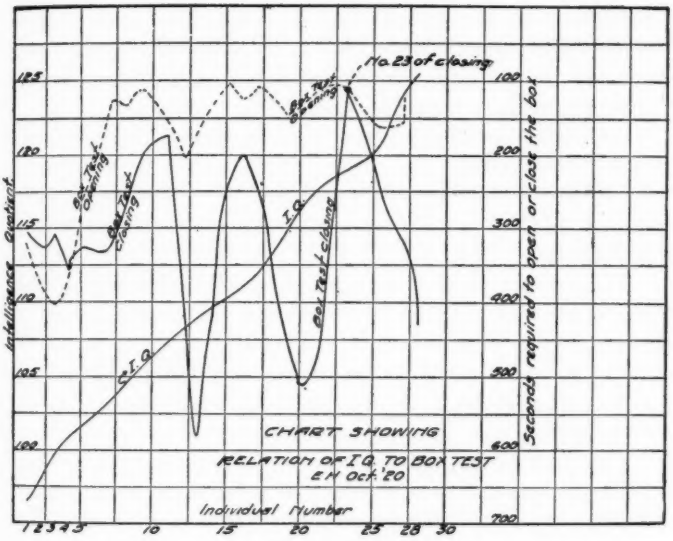


DIAGRAM III.

The high-school pupils were all given the Otis Group test for general intelligence, and the median of the school was 141.2. Of this group it was 130.5. The correlations here were:

Time for opening and Otis	.09
Time for closing and Otis	.316

The same indication exists, that although there is no marked correlation between mechanical ability and intelligence, closing involves more intelligence than does opening. The very small number of these high-school freshmen who closed the box makes it impossible to base any conclusive statements on these correlations.

The third group, the senior engineers, took the Army Alpha test. Their median was 147, again well above the median of the engineering students generally. Now correlating these grades with time to open and close the Puzzle Box, we get the following correlations: .24 and .09 respectively. Here the result is just opposite from that in the other two groups: *i.e.*, opening has a higher correlation than closing. The correlations are low as in the other cases.

Similarly, the following facts indicate the lack of uniformity of the three groups:

10.7 per cent. or 3 of the miscellaneous failed to close box, and of this per cent., 0 per cent. were below the median in intelligence.

55.5 per cent. or 10 of the high school failed to close box, and of this per cent., 50 per cent. were below the median in intelligence.

13.7 per cent. or 4 of the senior engineers failed to close box, and of this per cent., 75 per cent. were below the median in intelligence.

Therefore we may conclude that intelligence and mechanical ability depend little on each other, in so far as the time element in the Puzzle Box indicates mechanical ability.

From all evidence that we have, we may deduce the following statements, which are indications only and must be modified by the consideration that with as small numbers as we are dealing, no evidence, however strong, can be regarded as at all conclusive: First that

(*a*) many individuals who have a reputation for excellence or failure in mechanical lines show this by their degree of speed in opening the Puzzle Box.

(*b*) a minute and a half to open and about twice that to close, may be taken as approximate standards for the Puzzle Box.

Second, that

(*a*) according to one's performance in opening the Puzzle Box, so will he tend to do in shop work.

(*b*) accepting tentatively the definition of mechanical ability described above, and assuming that it is a reasonable expression of the qualities determining success in shop work, the time in opening the Puzzle Box is a fair test for mechanical ability.

(*c*) improvement in grade of shop work with reference to the time of opening the box, is fairly uniform according to percentile grouping.

Third, that

(*a*) general intelligence has little in common with speed in opening or closing the Puzzle Box.

(*b*) providing this test is a fairly accurate measure of mechanical ability, the man who excels in this ability should not be expected to possess necessarily a high or low level of general intelligence.

SECTIONAL AND BRANCH MEETINGS.

BY G. C. ANTHONY,

Past President of the Society.

The success of the New England Sectional meeting of the Society at the University of Maine, following the very successful meeting in Worcester last spring, leaves little room to doubt the usefulness of sectional meetings. If, too, the Branch meetings at universities shall prove as profitable as that recently held in the Engineering School of Tufts College, in accord with the suggestions of the "Foreword" of President Scott, there is every prospect of a much needed revival in the Society.

In considering the influences which have contributed to the success of the New England Section, it seems to me that the spontaneity and enthusiasm was due in no small part to the freedom from a fixed program, the absence of papers read at the meetings, and the serious desire on the part of those present to lend their assistance to promoting engineering education in general rather than the special course or professional field in which they were interested.

The rather serious note that was repeatedly sounded in the evening meeting emphasized the great importance of the personal influence of a teacher rather than of the subject taught.

It was gratifying to have so large an attendance of non-members who so uniformly expressed their appreciation of and a desire for coöperation with the work of the engineers. It is a good omen to the broader view of the Society which the President is advancing. We need a perspective which shall enable us to appreciate the influence which the S.P.E.E. should

exert in the United States and which should not be second to that of any National Society.

We need more enthusiasm, bigger ideals, a greater appreciation of the influence of the teacher, and I know of no better method of creating these ideals than through the personal contact which can be obtained in these Sectional and Branch meetings.

TUFTS COLLEGE BRANCH.

The first meeting of the Tufts College Branch of the S.P.E.E. was held on the evening of October 11 with twenty-one members of the faculty present. Professor Charles H. Chase, institutional delegate to the New Haven meeting in June, presided.

The chairman first read portions of Professor Scott's letter in explanation of the purpose of the meeting, and followed this with a very interesting informal report of the meeting at Yale. After referring to the provisions made by the University for the entertainments of the delegates, with special mention of the new Harkness dormitories where they were lodged, he gave in such detail as the limited time allowed his impressions of the several sessions and the notable papers presented. The meeting was then thrown open for the discussion of problems encountered in the teaching of engineering subjects.

The difficulty of getting the students to make sufficient and proper use of their textbooks was presented and this brought out opinions to the effect—

1. That students have not been trained before coming to college to work out things for themselves.

2. That they do not know how to study a text and select the important material from it.

3. That they are inclined to depend too much upon the teacher.

4. That interests outside the classroom make great demands upon the students' time.

One professor referred to an experiment which he is trying, as an aid to one of his classes in the preparation for recitations, wherein he furnishes each day a list of the important points in the next assignment.

It appeared to be the opinion of the meeting that further

consideration of this question might disclose ways of helping the student to make better preparation for class.

The question of aiding the inexperienced teacher to do more effective work was brought up and the discussion of this was confined principally to the desirability of supervision and criticism of his work in the classroom, and visits to other classes for the purpose of observation. Instances were cited where such supervision had been helpful, but no definite conclusion was reached.

The last half hour of the meeting developed into a general discussion of such topics as—

1. How to make greater use of the library.
2. Desirability of setting the pace in a class according to the capacity of the abler members.
3. Necessity for sound training in fundamental theory with ample use of mathematics.
4. The educational value of requiring work to be presented strictly on time in order to be accepted.

With regard to the last, it was the opinion of the majority that, once the requirements for a course have been settled, the class should be held strictly to such requirements.

The meeting adjourned at ten-thirty, but it was noticed that the discussion was continued informally for some time thereafter and even on the street as the members made their way homeward.

EDWIN B. ROLLINS,
Secretary.

THE NEW ENGLAND SECTION.

The fall meeting of the New England Section of the Society for the Promotion of Engineering Education was held at the University of Maine Saturday, October 15. Most of those in attendance came upon the Boston boat, which arrived in Bangor at 10:30. They were taken in automobiles to the Campus, and, after an inspection of some of the buildings and laboratories, a luncheon was served by the University at Balentine Hall.

The first meeting was called to order by Dean G. C. Anthony, chairman of the Section at 3 P.M. An address of welcome was extended by J. N. Hart, dean of the University, to which Dean Anthony responded. The records of the Worcester meeting were read and approved. Voted that the next meeting of the Section be held at Brown University. Professor W. S. Franklin was then introduced. The topic for discussion being "The Teaching of Physics in Technical Schools," Professor Franklin, in his opening remarks, discussed college physics text books. As nearly every Engineering college in New England was represented by a member of the Department of Physics, the discussion was active and energetic.

The afternoon session adjourned about 6 P.M., the entire party going to Bangor, where supper was served at the Penobscot Exchange, after which the evening session took place. Various matters were discussed at this session, a considerable amount of time being very pleasantly taken up by President Scott and Vice-President Hughes, who discussed coöperation between Departments and the aims of the Society. Professor Adams proposed a resolution of heartiest appreciation of the efforts of the secretary and other deans and members of the faculty of the University of Maine who contributed to the comfort, entertainment, and success of the meeting. The

resolution was adopted by a rising vote. The secretary announced the attendance as follows: afternoon session, 40; evening session, 54. Of this number, 20 were members of the Society. The following institutions were represented by a member of the Department of Physics: Yale, Dartmouth, Tufts, Technology, Worcester, Norwich, New Hampshire, Harvard, Brown, Columbia, and Colby.

H. S. BOARDMAN,
Secretary.

WHAT IS THE MATTER WITH PHYSICS TEACHING?[1]

BY WM. S. FRANKLIN,

Massachusetts Institute of Technology.

The recent appointment by the National Research Council and by the American Physical Society of committees on the teaching of physics shows that our physicists who are primarily interested in research are beginning to see that something is the matter with the college teaching of physics. The question in everyone's mind is, "Why the widespread dislike of physics by college students?" As a long-time member of this society I have had much intercourse with engineering teachers, and I have long had in mind an additional question: "Why the widespread contempt of physics teaching among engineering faculties?"

Before giving my answer to these questions, I must point out that there is one kind of contempt of physics teaching among engineering teachers which is to the discredit of engineering teachers themselves, namely, the contempt which many of them have for straight and accurate thinking which does not conform to their own careless ways. When I meet with this contempt, which is much too often, I am sorry to say, I always think of a phrase P. G. Tait used in a discussion he gave many years ago of the perennial question of elementary mechanics. "In defense of accuracy," says Tait, "we must be zealous, even unto slaying." It must be conceded that P. G. Tait's ideas concerning elementary mechanics were and are absolutely correct as far as they go, and, after agreeing to use the word weight to designate the pull of the earth on a

[1] The opening of a discussion of physics teaching at the Orono meeting of the New England Section of the Society for the Promotion of Engineering Education; Autumn 1921.

body, he never reverted to the usage of the grocer and the coal man. This is a thing many of our engineering teachers do, and it is a thing many of us physics teachers never will do.

Concerning physics teaching, my own opinion is that students dislike physics because they accomplish so little in the study of it in our elementary college courses; and I believe that they accomplish little because the simple, fundamental mathematical ideas and methods which constitute elementary physics are not sufficiently stressed in the class room and not set forth with clearness and brevity in our textbooks.

"The instantaneous acceleration of a body is the limit of the ratio $\Delta v/\Delta t$ as Δt approaches zero, where Δv is the change of velocity in time Δt " ; but the limit of $\Delta v/\Delta t$ is unthinkable unless one knows the manner in which Δv and Δt approach zero. Advanced students supply this deficiency, as they look backwards at such a definition, by thinking that they think of the so-called principle of continuity! But what is the principle of continuity to a beginner? And what is the beginner to do? The definition of instantaneous acceleration cannot be given either logically or intelligibly except in terms of a specific algebraic example where the manner in which Δv and Δt approach zero is clearly evident. I mention this definition of instantaneous acceleration because it is given as stated in nearly every physics text known to me; and yet we ask why students dislike physics. Many physics teachers maintain that it is the business of our mathematics teachers to clear up all mathematical difficulties; but I believe, most decidedly, that the main business of the physics teacher is to coöperate with mathematics teachers in this extremely important matter. I am here considering mathematics largely as a method of thinking, and, surely, if all the difficulties in this method of thinking were cleared up by our mathematics teachers there would be but little left for us physics teachers to do.

Let us consider another example. A fluid at rest pushes normally on an exposed surface, or the exposed surface pushes normally against the fluid. Most of our physics textbooks

attempt to explain this fact by stating that the shear modulus of a fluid is zero! Or by the following pseudo argument: "If the force exerted on the fluid by an element of the surface were inclined to the surface it would have a component parallel to the surface, and this tangential force would set the fluid in motion; therefore, etc., etc." Now it is absurd to say what this tangential force will do to the small adjacent portion of the fluid without considering the forces exerted on the portion by the surrounding fluid. Many such pseudo arguments may be found in almost any of our physics texts, and I believe they account in large part for the difficulties our mathematics teachers have in the teaching of mathematics. Our physics teachers not only do not help in the important matter of mathematical training but they sometimes hinder this highly important business.

But slovenliness in mathematics is not the only fault in our physics texts. Many a student comes from his boarding house to the class room to hear the physics teacher formalize about position and displacement, although not one of the formalities needs to be used, because the student's already existing knowledge of coming and going is fully sufficient for everything his physics teacher will give him. No wonder that a student never *goes* from the classroom to his study to read about position and displacement in his physics text, even if there should be the grain of a new idea mixed up with the intolerably stupid and immediately purposeless discussion.

A young man from the high school is expected to be edified by the study in college of a physics text which discusses levers of the first, second, and third classes, which gives all the old stuff about "simple machines"; and which contains little else that is clear and concise and correct and purposeful!

In the technical school the student is scheduled to study such things as water wheels, and pumps, and engines, and yet he is expected to study a physics text in which all these things are set forth, but no more completely than in his high-school

physics text. This surely is a side-stepping procedure on the part of the physics teacher, because the student's burning need is to be trained in mathematical thinking, and it is absurd to waste time in any descriptive study unless it be with some immediate and attainable analytical end in view.

To illustrate faults of physics teaching by examples chosen from mechanics is comparatively easy; but to illustrate by examples chosen from the equally important subject of electricity and magnetism is very difficult. One reason for this difficulty is, of course, evident; but, in my opinion, the chief reason of the difficulty is that the usual presentation of the elements of electricity and magnetism is so bad as to be beyond the range of intelligible illustration, so bad as to be actually unthinkable! Here is an attempt at an example, and I might attempt a great many as unthinkable as this! Any wheelbarrow pusher may, if he chooses, think that when he stops a wheelbarrow he does not simply stop it, but he imparts to it an "extra velocity" in a backward direction. No one would quarrel with such a wheelbarrow pusher, much as one might be tempted to poke fun at him. But what of the textbook-writing physics teacher who injects into a many-page discussion of self-induction the essentially useless idea of "extra current," and in a way which, when reduced to wheelbarrow language, is exactly equivalent to thinking that he thinks that the "extra velocity" to be imparted to a stopping wheelbarrow is a forward velocity! And yet we ask why students dislike physics.

The above examples of unintelligible half-way mathematics, of fallacious argument, of purposeless formality, of tiresome repetition and of easy side-stepping have been chosen from the subject of mechanics, and the one attempt to illustrate the futilities which ordinarily pass as the *elements* of electricity and magnetism has led us back again to mechanics! Why? Because mechanics is the only branch of physics in which a real beginning has been made in the use of precise ideas by common men.

I know, from experience, that most of our students like physics when the teaching is directed insistently towards the development and use of precise ideas, and I know that the majority of our students can be carried a long way in this difficult but highly profitable business.

But the greatest difficulty in the teaching of physics is to persuade the student to study his text book, and in the face of this difficulty physics teaching has degenerated into interminable classroom coaching, making our teaching not only very exhausting but also frightfully expensive, and greatly weakening the morale of our students. What are we to do about it?

President Hadley made a statement in a brief address before the New Haven Convention of this Society in June, which alone would justify the Convention if it could be taken to heart by our teachers. He said that, although at one time, many years ago, books were used too much, or, at least, too slavishly, they are now used too little; and the most pressing present need in educational work is to place more dependence on books. What are we to do about it?

No one would wish a student to use a book unless he can be led to use it effectively, and the trouble, in physics, at least, is that our textbooks cannot be used effectively. I am, of course, familiar with what is usually considered to be an effective use of a physics text in our non-exacting college courses in physics which run largely to appreciation-stuff, but I do not consider such use to be effective, most emphatically I do not.

I have discussed college physics teaching with a great many men, and when the discussion has turned to the question of the textbook I have always been struck by the tendency of those whom I have known to be the best of teachers to point out the contrast between what they say and do in the classroom and what stands in the textbook, compendium of all the manifold allusions, suggestions, plausibilities, comparisons, analogies, cross-references and explanations which enliven the

recitation and lecture and which serve as nothing else can serve to stimulate the student's imagination; but no student can work on such things, and the textbook must be something on which he can work.

The idea is somehow widely prevalent among students, and also among teachers, that the understanding rather than the memory should function in the study of physics; but no one can understand anything until many things are fixed in the mind. The student should be required to burn into his memory all definitions, all statements of principles and laws, all elementary proportions with their proofs and all important equations with their derivations. When he does this he will get a hundred times as much as he can otherwise get from his lectures and recitations, the sum total of his effort will be reduced, and his worry will cease to exist.

The most distressing idolatry the world has ever seen is the modern, popular, science-worship which pays no tithes and takes no pains. It is our Great Religion. Its catechism is science teaching which abhors exactions; its litany is the semi-serious wail of regret of our easier college graduates that a silver-spoon smartness was not transmuted by a pleasant college course into what they conceive the talents of its priesthood to be; and its beatitudes are the above-mentioned appreciation-stuff which imbues every easygoing dilletant with a false sense of understanding the universe and encourages every would-be parasite to think exaltingly that science is the building of steamships to carry him where he has no need to go, of railways to bring him things he could do better without and of airplanes to carry quickly his letters which could not lose in meaning if their time of transit were to take a thousand years!

Most people think of science in terms of its results, chiefly, indeed, in terms of results which facilitate joy riding of all kinds, including easy orgies of near-thinking; but science is Finding Out and Learning How, its great gift to those of us who live inside of its frontiers is an understanding of the

things which surround us and of the things we have to do, and its price is pains.

The teacher must not mistake the fixity of an idea as its *raison d'être*. As relating to ideas fixity and reason are not the same thing, especially when it comes to transmitting ideas to students.

The teacher who mistakes fixity for reason does not, as a rule, exercise himself greatly in his teaching; and the teacher who does put energy into his teaching needs, above all things, to guard against what may be called the "illusion of activity" which is the feeling that one is doing a thing well when one is doing it with all one's might! When a teacher does a lesson with all his might, the students may be doing nothing at all.

It is not the teacher's business to promote the use of the metric system, partly because any effort he may make in this direction is pretty nearly sure to be wasted, and partly because he has too much else to do.

Let the teacher use familiar units wherever possible. In mechanics let him use English units and refer briefly to c.g.s. units. In electricity and magnetism let him use the units of the volt-ampere-ohm system wherever these units can be used, and let him use the electromagnetic c.g.s. units where it is necessary to use them.

Nothing in the teaching of physics is of greater importance than to frame numerical problems so that the data as given might be determined by actual laboratory test. The consistent following of this rule will do much to develop physical sense in the student; and neglect of this rule is sure to leave the student "up in the air."

Ask a student about the effect of an unbalanced force on a body and he is apt to make the following sounds in answer: *eff equals emm aye!* Do not tolerate the mere reading of an equation in answer to a physical question.

Do not tolerate vague statements. It is physically meaningless to say, for example, that "acceleration is gain of velocity

divided by time." The proper statement is that the average acceleration *of a body during a given time* is equal to the velocity gained *by the body during the given time* divided by the time. It is meaningless to say that "density is mass divided by volume." The proper statement is that the density of a body is equal to the mass of the body divided by its volume.

Require the student to make every statement of definition, every statement of principle, every explanation of an equation, etc., as relating explicitly to a particular condition or thing.

The natural desire for brevity of statement is often allowed to go much farther than the elimination of the important element of explicitness as above pointed out, and lead to complete obscurity of meaning as illustrated by the following example: A string 10 feet long is tied to a post and a force of 5 "pounds" is exerted on the post by pulling the string. This force certainly "acts through a distance of 10 feet," and, the work done is 50 foot-"pounds" because "work is done when a force acts through a distance." This argument is found to be acceptable to about 60 per cent. of the men beginning a college course in mechanics! No! *Work is done when a body on which a force acts moves in the direction of the force,* and no dictionary ever defined the word *through* in a way to justify the use of the word to abbreviate this 18-word statement as it is usually abbreviated in the study of physics (?) in school and college. Language has been developed as a medium for dickering, quarreling and love-making, and language as used in precise physical specifications is always more or less awkward and more or less strained; but it is a serious mistake to obviate these things by using meaningless expressions and phrases.

I have never talked with an electrical engineer who retained any helpful knowledge or understanding whatever from the study of electrostatics in his college course in physics; and every electrical engineering teacher will tell you that he cannot count on any knowledge or understanding, even incipient

knowledge and understanding of electrostatics among students who have just finished their college course in physics.

DISCUSSION.

Comfort A. Adams: The most serious defect in our engineering education today, and it is very serious, is too little physics; that is, too little of the fundamental science underlying engineering. I refer not only to the physics taught by physics teachers, but also to the physics taught by teachers of engineering; for we all teach physics. If some of us don't we ought to.

The tendency in our engineering schools is to rush through the fundamentals into special applications, making each application a subject by itself, instead of an opportunity for an interesting illustration of how the laws and concepts of physics can be made to serve a useful purpose and for the hammering home of those laws and concepts.

Our engineering education is for the most part brutally superficial. In many cases the professors themselves are deficient in their knowledge of the fundamentals, *i.e.*, of physics. What we need is more physics and "then some."

For the past thirty years I have been trying to teach electrical engineering to students who were supposed to know elementary physics, and have devoted in each of my courses a considerable amount of time to a review of elementary physics, because it was necessary. I have finally come to believe that the teachers of physics make some of the same mistakes that we do in engineering; *i.e.*, fail to insist on a thorough knowledge of the fundamentals, and in training the men in careful habits of analysis. In other words, we fail in the primary object of education, which is to train the student to use his own mind, to make a subject his own, to scrutinize the basis of fact and principle and to think straight on that basis.

I am convinced that every healthy minded boy who gets a real grasp of the fundamentals of physics and the habit of interpreting the phenomena of the physical world about him

in the light of those fundamentals, will be not only interested but fascinated. The fact is that he does not get a thorough grasp of anything; he is hurried through without having time to digest any part of the subject, or to make it his own.

The fault is partly in the lack of time to cover the ground thoroughly and partly with the teachers, of whom, however, I am not inclined to be critical, as I know the difficulty of the task.

My answer is: either our engineering departments should allow more time for the teaching of physics by the physics departments, insisting on a thorough understanding of the fundamentals; or that every teacher of engineering should systematically utilize his courses primarily as a review of the branch or branches of physics involved, and only secondarily as a means of familiarizing the student with the more practical or applicational side of the subject; or better yet, a good deal of both.

As I see it, the chief reason why physics is so difficult to teach, is that it demands a habit of exact analysis, of the accurate definition and use of words, in which the average student has little or no previous training. To succeed in physics he *must* think straight, he *must* understand completely and accurately the meaning of the words and symbols which he employs. In contrast to this, consider the average conversation or discussion between so-called educated citizens on subjects of an economic, political, philosophical or religious nature. For the most part, they start anywhere without regard to a basis of fact or principle and end nowhere; a mess of phrases and glittering generalities which "listen well," but mean nothing; a loose use of words which mean one thing to one man and something quite different to another. The habit of clean hard thinking is not there. It is easier for most of us to remember than to think.

Thus the average student shuns thinking as a cat shuns water. If he has a problem to solve he wants to be told how to solve it, what buttons to push and what levers to pull; the

thought that he could really understand it and develop his own solution rarely enters his head. No wonder that he does not find physics interesting.

Thus it is that the teaching of physics is of double importance, not only because of the use to which it can be put in the solving of engineering problems, but also, and this is if anything more important, because it is an exceptional opportunity to develop the habit of clean straight thinking.

Finally and again, what we need is more time for physics, and a more thorough teaching of it.

George P. Bacon: The course in physics in a classical college is intended to give a foundation of scientific information and training. In an engineering school the other courses go much further in such lines and physics is taught with several other purposes, prominent among which the the unifying and rounding out of many otherwise individual lines, the cultivation of the attitude of precision, the process of thinking out conclusions from axioms and definitions rather than experiment alone, the teaching of a comprehension, at least, of the research attitude of mind and above all the emphasizing of correct processes of thought.

The study of physics involves three processes, memory, reasoning, and expression. The disregard or misplacing of either leads to a dislike of the subject and often to failure. It is the duty of the teacher of physics to set the daily task and the task for the term that it will become clear to the student when to exercise each of these functions.

The ideal textbook that contains all that the student needs to know and no more and states it in the best possible words would be a poor tool for instruction, for the student would soon realize that the ideal preparation would consist in memorizing everything in sight instead of learning to search for that which must be memorized and exercising and developing his own powers of consecutive thought and of expression.

H. J. Hughes: Such subjects as mathematics, physics, chemistry and English are too often regarded by teachers and

students alike as mere preliminaries to the study of the "engineering courses" (so-called). For lack of time or interest, or of both many engineering students never get the sound training in mathematics and science, and in the use of English which they need. There are far too many engineering graduates who can handle successfully problems of familiar types involving considerable technical knowledge, but fail when called upon to solve new problems which require clear thinking and the accurate use of mathematics and of the fundamental principle of science. This condition is largely due to the fact that the students understand that teachers with engineering training and experience put a higher value on their own type of course (that is, the technical) than on the non-technical work.

Students work willingly on things which interest them or which they think worth while. A better mutual understanding between the two groups of teachers as to the real objects of engineering education, and of the best means to obtain it, will lead the students to a truer evaluation of the different parts of their courses of study.

James S. Stevens: I do not feel seriously disturbed over the reputation which the various courses in physics seem to have for unpopularity. We should make a distinction between unpopularity and difficulty. Our best technical students take rather kindly to the physics courses and the poor ones have no liking for anything in the curriculum. It is quite to the credit of the departments of physics that their courses are difficult. It is only by hard intensive work that trained minds are produced. If I were to suggest anything which engineering professors could do to assist the teachers of such subjects as physics, chemistry, and English I would say that they should endeavor to free the minds of the students (and possibly their own minds) from the notion that these courses are necessary evils and that the real object of a technical training is to master the various practical courses which come in the senior year. I am glad to testify that no such feeling exists

in the College of Technology here. We are working together very harmoniously and I am sure we shall all find the discussions of this session extremely helpful.

G. V. Wendell: I have listened with great satisfaction to the remarks of the several speakers and in particular to those of Dean Hughes and Professor Comfort Adams. Their insistence upon the importance of a thorough grounding in the fundamentals with the elimination of the so-called practical courses and the reduction to a minimum of descriptive courses is timely. With too many courses of this nature in the curriculum there is not sufficient time remaining for an adequate treatment of those basic subjects on which engineering rests.

What is needed in our engineering schools is a training that will develop in the students power and the ability to think straight. This cannot, I believe, be accomplished so long as a considerable portion of the curriculum of the four-year engineering schools contains provision for instruction in engineering practice which cannot be effectively acquired except in the field. Such material should be cut out to give adequate time for the instruction in the fundamentals of engineering.

In so far as the elementary physics is concerned, the unanimous sentiment of those present seems to be that physics is of the first importance in the training of the engineering student. This being granted, the question arises, "Why are the results of the physics instruction so often unsatisfactory to the professors of engineering?"

It is my opinion, based on years of experience, that the results of the physics teaching will not prove satisfactory in our engineering schools until an adequate allotment of time is made for the teaching of this subject. I am confident that in many schools the course in physics has been most carefully laid out and the instruction is of the best, but in the insufficient time that is allowed, better results cannot be obtained. The subject is inherently a difficult one, and the acquirement of the power to use the fundamental principles correctly and with confidence, requires more time than the faculties of our

engineering schools have been willing to give. Improvement in the textbook situation, while desirable, will not solve the problem. If the engineering schools want their students to be able to use physics with intelligence, they must make a larger provision for physics instruction in the curriculum.

If this is done, I feel confident the professors of engineering will, in those subjects for which physics is indispensable, be able to cover the present ground in much less time and the students will assimilate the subject matter far better than under existing conditions.

Persons who took physics some years ago are prone, from their own experience, to believe that too many topics are treated in the physics course and to hold that a considerable reduction in this material would give better results and react favorably on the student. I think I am correct in the statement that in many of our engineering schools the non-essentials in physics have already been stricken from the course and moreover, of the material presented, only the fundamentals are treated. Further reduction in this direction seems impossible.

The wise handling of the phyiscs instruction requires a coördination of the work with the engineering courses that follow. In addition there should exist such close coöperation between the departments of physics and engineering, that the physics instructor will be kept informed of the needs of the engineering departments. This coöperation will also tend to prevent those thoughtless criticisms of the physics instruction that often do much to weaken the influence of physics (and the same is true of mathematics, chemistry and the humanistic subjects) by awakening in the student's mind the false idea that physics is not considered by the engineer a vital part of the engineering training. Such unintentional reflections by the engineering instructor are in part accountable for the lack of interest shown by some engineering students for physics.

Sound thinking requires accurate knowledge and a thorough

acquaintance with the principles. If we are to turn out of our engineering schools young men who have the power to analyze and solve new problems with assurance and who have the scientific background on which to grow, there must be more attention given in our engineering schools to the teaching of the fundamentals of engineering and less to engineering practice. Both cannot be given in the short time at our disposal. Our aim should be to turn out thinking rather than empirical machines.

G. F. Wittig:—Teachers of physics and teachers of its applications in engineering have a common problem to face: the students' failure to visualize the subject. It is a problem in which we can all coöperate sympathetically.

Why do the students dislike physics? Because physics comes to them in the form of a myriad of facts, primarily. These are so numerous that the students' ability and previous training in the association of ideas cannot be adequately utilized. They pass in review so rapidly that only a casual acquaintance with them is possible. He fails to visualize them. Hence there is rarely that feeling of satisfaction that comes with the acquisition of skill. What is learned in December serves scarcely at all to review and to strengthen what was learned in October and November.

What is the aim of a physics course? Most of us will probably agree on two general objects: acquisition of knowledge of physical facts and ability to reason correctly on physical problems.

We probably do not appreciate the odds against which teacher and students are working. An analysis of 10 pages selected at random from a widely used college text-book revealed, as nearly as such things can be enumerated, 142 statements of physical facts, 52 deductions, mathematical either in form or in essence, 10 definitions, 1 table of constants on which the student ought to spend time in comparisons and analysis, and 12 diagrams to be traced through in conjunction with the text.

Some of the statements involved several arbitrary constants, up to six significant figures; similar constants occurred in the definitions; these latter, surely, were to be memorized.

The facts were not related to any previous experience of the ordinary student. They did not utilize to any considerable extent his associative faculty. They were of a type that was probably quite new to him, and quite abstract and intangible. Now this enumeration means, in the case of a 500- or 600-page book some ten thousand facts, to be acquired not by trial, not by examination, as one naturally learns about material things, perhaps in small part by demonstration lectures and laboratory exercises, but in the main by direct memorizing.

The second aim of our courses is to develop the ability to reason correctly on physical problems. With the facts only vaguely learned and generally unassimilated, analysis becomes difficult; the problems remain in part meaningless; the processes of solution are carried out mechanically in a haze. The dislike on the part of students, and what Professor Franklin calls the "contempt" on the part of engineering faculties (if so strong a term is warranted) has its root not in hostility but rather in disillusionment and disappointment. If that feeling can be overcome by suitable changes in the instruction, the question will vanish.

Specific remedies are more difficult to suggest. So much earnest thought has been given the matter for years, that clearly the solution is not simple nor obvious. But certain possible lines of attack do suggest themselves.

1. Touch only as many topics as can be really studied; there is danger of mere cyclopedic cataloguing.

2. If a thing is worth studying at all, it is worth interpreting not merely by mathematical symbolism but by concrete examples. Thus, the velocity and the acceleration in simple harmonic motion either is or is not worth considering. If it is, we must go vastly farther than a mere $a = -wzx$. Calculate and plot v and a for a given tuning-

fork which he can actually see. How do the magnitudes compare with those of a bullet fired from a gun? Why the displacement of the curves? And that means discussion, not metaphysical, not definitional, but comparative, putting fact against fact, exercising judgment. A simplified engine cross-head problem serves the same purpose. If that means omitting the equation of the compound pendulum, well, then, out with it. Or out with the other!

3. Indicate definitely, in the textbook, the very few constants that need to be learned. Of what use is it, for instance, to commit the legal value of the ampere to memory?

4. Satisfy the natural craving to know how things were found out, and why devices work. The descriptions are so compressed as to be scarcely intelligible to one who does not already know. Reduce the number to be studied.

5. Avoid needlessly fine distinctions. If you have to bring in the moon to elucidate the difference between center of gravity and center of mass, why not leave out the moon and overlook the difference? If the electrical engineer can dispense with the distinction between lines of force and lines of induction, why trouble the sophomore? Loose thinking? Absolutely no. Rather, opportunity for more analysis, of things more worth while.

6. And last, physics takes time to be absorbed—to be related to our daily experiences through which so much of its elementary aspect can be best comprehended, remembered, and applied. I believe it is educationally sounder to use 5 hours weekly for two years than 10 for one. That question ought not to be unsolvable.

Professor A. Wilmer Duff:—As one who shares with Professor Franklin the sins of the writers of textbooks, I wish to express my agreement with Professor Franklin on some of his criticisms but my dissent on other points of fundamental importance. The central point of his argument I take to be his answer to the problem why students do not love their physics more devoutly. He traces it to lack of mathematical rigor in the matter of definitions and proofs. Now no proof of any-

thing is ever absolutely rigorous. Proof is relative to the development of the student. I believe it to be a serious mistake to introduce mathematical considerations not demanded by the nature of the subject or of a nature more suited to students of a more advanced grade. For example, in the definition of an acceleration by means of the limit of the quotient of an increment of velocity by an increment of time, it is assumed that the variation of velocity is not discontinuous. Now no actual velocities of real bodies vary discontinuously, for force is never infinite and mass is never zero. The consideration of velocities conceived as varying discontinuously is extraneous to physics and should be left entirely to the course in mathematics. There are difficulties enough in physics without introducing purely mathematical difficulties. To ask a student in physics to even imagine velocities which vary discontinuously would only confuse a beginner. Functions with such properties are properly discussed in the courses in mathematics. In the writing of a textbook of physics, as well as in the teaching of physics, we should avoid introducing difficulties not inherent in the subject, in order to offer explanations which the student will not understand. A second consideration is that it is even more important to create correct, fruitful and stimulating intuitions than to attain the appearance of mathematical precision and rigor, for intuitions from the starting points of fruitful thinking. A third important consideration, especially in the composition of a textbook, is that there shall be a reasonable degree of continuity and logical consistency in the development. This justifies the brief treatment of topics which cannot be omitted without leaving obvious gaps. If the student is already familiar with such topics, they may be omitted, or, if they are included, the brief review is no disadvantage. If he is not familiar with them the omission would be a decided disadvantage.

Without going into details these considerations will, I believe, take care of the special criticisms advanced by Professor Franklin. As to his general criticism that all existing text-

books are far from perfect, I am in entire agreement. But this does not at all justify the conclusion that the imperfections of textbooks form the chief reason for the unpopularity of physics to which Professor Franklin has referred. I believe that the chief cause must be sought elsewhere. The replies to a questionnaire recently issued by the American Physical Society show that in the opinion of the physics teachers of the country generally, only a small part of the blame is to be attributed to the deficiencies of textbooks. The opinion of the majority is that there are several textbooks which will yield good results in the hands of a good teacher, and that the real sources of the difficulty are (1) the inherent difficulty of the subject, (2) a lack of appreciation by the student of its practical importance, (3) the inadequacy of the time allowed. As regards the first we shall not, I believe, make the subject more attractive by making it more mathematical. As regards the lack of appreciation of the importance of the subject, it is to be noted that a group of practising engineers to whom the questionnaire was sent were emphatically and unanimously of the opinion that physics is the most important fundamental part of the education of an engineer, and that much more attention should be devoted to it, even if less time has to be spent on the so-called practical technical subjects. In this there is, I believe, a marked divergence of opinion between practical engineers and many teachers of engineering subjects. How this divergence of opinion is to be reduced, and how an adequate allowance of time is to be secured for the efficient teaching of physics, I leave to other speakers.

John Zeleny:—It is highly gratifying for a physicist not only to hear such unanimity of opinion among the engineering men who have spoken that a thorough knowledge of physics is of most fundamental importance for the student of engineering, but also to find that some advocate a reduction in the time devoted in the curriculum to purely technical studies so that more time might be given to physics than is now done.

I do not believe that the study of physics is distasteful to the average student of engineering provided that enough time is given to the subject to enable him to get a firm hold on it. Aversion to the subject starts when new ideas are presented faster than the student is able to comprehend or master them.

Two things are necessary for the successful teaching of physics, one is persistence and the other insistence. Members of engineering faculties can be of invaluable aid to the physics teacher by helping him to persist in his efforts and to insist on real work by the student. The nature, newness and number of the ideas presented in physics is such that much repetition is necessary if the student is to retain these ideas and see their interrelations. We must accordingly have enough time allotted to the subject to permit this intensive study.

In the next place it is well known that the average student will sidestep a difficult task if allowed to do so. We are too apt to encourage him in this by accepting half-formed notions and inaccurate statements. We must insist on his thinking enough about the subject to get clear ideas. If he refuses to do so he must not be passed on; and the engineering faculty should uphold the instructor in this action. Nothing demoralizes a physics class so much as having a professor of engineering speak to one of his students in the slightest way disparagingly of the subject of physics or of the way it is being taught. Such a remark soon reaches the whole class in magnified form and encourages many of the men to slight the subject. It is essential therefore that you engineering men not only feel the importance of our science for your students, but also that you give us time to teach it adequately and uphold us in maintaining proper standards.

As regards the matter of attempting to secure a more acceptable textbook in physics by some kind of coöperative editorship, I think that one of the difficulties in the way

consists in the differences of opinion as to what should be or should not be included in such a text. This arises in large part from the different lengths of the courses offered in different schools and from the course being begun in some places in the freshman year and in other places in the sophomore year. Something might possibly be accomplished by having one man assume the editorship of such a book, and by having him offer the intended matter for criticism, piece by piece, to a number of experienced teachers who would be willing to devote a considerable amount of time to the work.

COLLEGE NOTES.

The Municipal University of Akron.—The faculty of the Municipal University of Akron passed the following resolution:

1. That the Department of Commerce and Administration become a department of the Engineering College, which shall henceforth be known as the College of Engineering and Commerce.

2. That all students in secretarial courses or with major work in commerce, finance or production shall be registered in the College of Engineering and Commerce.

3. That the general regulations regarding election of subjects in other schools of the university as stated on page 32 of the catalog for 1920 be amended by the substitution of the following paragraph for the paragraph headed "College of Engineering."

College of Engineering and Commerce.—Students in Buchtel College may elect a maximum of twelve hours' work in the Department of Commerce and Administration of the College of Engineering and Commerce. Such credit may be used toward the elective requirements for graduation but may not be used to fulfil the major or minor requirements. Other subjects in the College of Engineering may be elected by liberal arts students only on the consent of the Classification Committee.

Work thus elected must not interfere with required major and minor studies in the College of Liberal Arts, nor can it be substituted for them.

4. That the existing major in Economics and Business Administation in Buchtel College be discontinued at the end of the school year of 1920–21, but that students now registered for this major be allowed to complete the course in the Liberal Arts College. Students in the secretarial course

shall be registered in the College of Engineering and Commerce in September, 1921.

5. That it is the sense of the faculty that the College of Engineering and Commerce shall prepare the following courses as soon as circumstances permit:

(*a*) A course in commerce and administration, consisting of major work in these subjects with other required or elective subjects chosen from the courses offered in the College of Liberal Arts.

(*b*) A secretarial course, including also subjects chosen from the courses offered in the College of Liberal Arts.

6. That outlines from these courses, together with appropriate degrees for their satisfactory completion, be submitted to the Faculty Council for ratification before their final adoption.

7. That some form of coöperative plan of training be adopted for these courses as soon as possible.

California Institute of Technology.—The board of trustees of the California Institute of Technology announces the appointment of Dr. Robert A. Millikan, formerly professor of physics at the University of Chicago, as director of the Norman Bridge Laboratory of Physics and chairman of the Executive Council of the Institute.

Dr. Millikan plans to devote himself mainly to the development there of one of the most important centers of research in the country, and it is the desire of the trustees that he be free to do this without being burdened with administrative duties. He is, however, greatly interested in the building up of the Institute as a school of science and engineering of the first rank, and while he has not wished to accept the position of president because of the public and administrative functions which are usually attached to that office, he is desirous of assisting in all larger ways in the development of the institution. This he will have opportunity to do in his capacity as chairman of the executive

council, which, subject to the board of trustees, will have charge of the administration of the Institute.

The board has undertaken to provide liberally for the support of the work in physics under Dr. Millikan's direction. This provision has been made possible by large gifts recently made to the Institute. When the laboratory is fully in operation an annual appropriation for its support of approximately $100,000 has been guaranteed. These funds will enable a large staff of able investigators and teachers and an unusually complete equipment to be secured. In addition to this provision for annual support, the Institute has recently received from Dr. Norman Bridge the promise of $200,000 for an extension of the Norman Bridge Laboratory and of $50,000 for its library.

It is also announced that the Southern California Edison Company will immediately erect on the campus of the California Institute a high-tension laboratory where an extensive investigation on the transmission of power at high voltages will be made by the staffs of the company and of the Physics and Electrical Engineering departments of the Institute under the direction of Dr. Millikan and Professor R. W. Sorensen, and where other scientific researches will be carried on by the professors of the Institute in coöperation with the Mt. Wilson Observatory. This high-tension laboratory will represent an investment of about $75,000.

The board of trustees also announces the appointment of Professor H. A. Lorentz as lecturer and research associate at the Institute during the winter term 1921–22, and the appointment of Dr. C. G. Darwin as professor of mathematical physics for the academic year 1922–23. Professor Lorentz has been for many years professor at the University of Leiden in Holland and is one of the leading mathematical physicists of the world.

Carnegie Institute of Technology.—With a view to enlarging the Department of Commercial Engineering which is one of the oldest courses of the kind, the Carnegie Insti-

tute of Technology has secured the services of Dr. Walter F. Rittman as head of the department. Dr. Rittman has been Consulting Engineer for the United States Government since 1916, on problems of explosives, fuels, oils and gases. He is well known in Pittsburgh, having practised as consulting and commercial engineer in the city for four years. He is a member of the Franklin Institute, the National Highways Association, the American Chemical Society and various other scientific organizations and clubs.

Two other appointments have been made in the faculty of the College of Engineering: W. L. Remick, a graduate of Harvard University, teacher of mining engineering, and John Tucker, Jr., a graduate of Stevens Institute, instructor in drawing and machine design.

A new system of nomenclature has been adopted at Carnegie Institute of Technology. The term College will be used instead of Division. There are now four Colleges: the College of Engineering, the College of Industries, the College of Fine Arts, the Margaret Morrison Carnegie College for Women. There remain, however the Division of Coöperative Research and the Division of General Studies.

Research, through teaching and research fellowship, will be carried on by the Coöperative Department of Mining Engineering of Carnegie Institute of Technology in coöperation with the mining industry of western Pennsylvania, and the Pittsburgh Experiment Station of the United States Bureau of Mines. The work will be devoted to various problems in coal mining and the utilization of fuels. Graduates of approved institutions will be eligible to fellowships. Advanced degrees will be granted upon completion of an approved course of study and presentation of a thesis.

Four fellowships have been established this year. The subjects for investigation are: a study of acid-resisting materials suitable for use in coal mines, a microscopic study of the Freeport coal bed with a view to the economical utilization of the bone and cannel coal constituents, a study of the relative tendency of the various Pennsylvania bituminous coals

to fire spontaneously, with particular regard to the influence of different coal constituents, and a study of the gas, oil and other by-products from the bone and cannel constituents of the Freeport coal bed.

Case School of Applied Science.—The enrollment one week after school opened was 632, divided as follows: freshmen 191, sophomores 162, juniors 160, and seniors 119. This is approximately a hundred less than last year, and smaller than was anticipated from the advance applications.

New men on the faculty include: Dr. H. H. Lester, from the University of Washington and commercial work, to be assistant professor of physics; Dr. J. J. Nassau, from Syracuse University, to be assistant professor of mathematics and astronomy; A. G. Aitchison, instructor in chemistry; J. G. Albright, instructor in physics; R. C. Brett, instructor in mechanical engineering; F. E. Curtis, instructor in English; K. H. Donaldson, instructor in mining; H. C. Esgar, instructor in mechanical engineering; T. F. Kortz, instructor in French; W. E. Mason, instructor in mechanical engineering; H. G. Metcalf, instructor in physical education; C. A. Miller, instructor in civil engineering.

Assistant professors C. D. Hodgman, of the department of physics, and K. O. Thompson, head of the department of English, have been advanced to be associate professors.

The last of the equipment of the department of astronomy has been transferred during the summer to the new Warner and Swazey Observatory.

Professors D. T. Wilson, of the department of astronomy, and W. D. Trautman, of the department of modern languages, have been granted leaves of absence for the coming year for further study or research.

Colorado School of Mines.—One hundred and ten members of the junior class recently made a ten-day trip visiting a number of important mining, milling and metallurgical plants in the state. Three Pullman cars provided the

necessary "hotel" accommodations during the trip. Throughout the junior and senior years these inspection trips are taken through the mining districts in the Rocky Mountains for the purpose of supplementing the laboratory work and for illustrating the lecture courses.

Due largely to an unauthorized article appearing in the *School of Mines Magazine* criticising the management of the school, the State Senate and House of Representatives appointed a Committee to investigate the management, standing and conditions prevailing at the School of Mines. Several weeks were spent in a thorough and painstaking investigation with the result that the Committee was unanimous in commending very highly the present management, faculty and student body.

A gold medal is being offered by Prof. A. P. Little, head of the department of electrical engineering, for meritorious work done by students, fellows or graduates of the Colorado School of Mines, in connection with the application of electricity to the mining, milling, metallurgical and chemical industries.

State University of Iowa.—Mr. Donald D. Curtis has been engaged as instructor in mechanics and hydraulics. Mr. Irving H. Pagenian has been engaged as instructor in drawing and descriptive geometry.

A new power laboratory is in process of construction and will be occupied during the current year.

The members of the technical faculty lunch together every Wednesday, and discuss matters of interest within the College and the general subject of Engineering Education. Four of last year's graduating class remain to do graduate work—one in electrical engineering, one in physics, two in hydraulics.

The hydraulic laboratory put into commission last year is being used by these men under Professor Nagler for research in connection with the possible utilization of the

hydraulic pump to increase the effective head on water wheels.

Kansas State Agricultural College.—The $190,000 addition to the engineering building at the Kansas State Agricultural College was completed last summer and is now being occupied by the department of electrical, civil, and farm engineering and architecture. It is expected to hold dedication exercises for this building on Homecoming Day, November 19.

Professor H. B. Walker, who has been extension engineer, has been made head of the Department of Farm Engineering.

Mr. Mark Havenhill, formerly power farm representative for the Cleveland Tractor Company of Cleveland, Ohio, succeeds Professor H. B. Walker as extension engineer.

Five additional instructors and assistant professors have been added to the teaching staff.

The engineering enrollment this fall has shown a marked increase over last year, about 725 collegiate engineering students having registered to date. The freshman class is especially large, some 320 having registered.

Lafayette College.—For the first time in its history Lafayette College required candidates for admission to the freshman class to take entrance examinations. The purpose was two-fold; to raise the scholastic standard of the College and to limit the enrollment, which was growing beyond the capacity of the institution. Over one hundred candidates failed to meet the requirements and the present freshman class numbers 277 as compared with 340 last year. The total enrollment, however, is about 50 more than last year, that is, about 840 undergraduates. The proportion of engineering students in the entering class is slightly greater than a year ago. It is expected that the mid-year mortality will be increased on account of the stricter entrance requirements and that the second semester enrollment will be considerably greater than last year.

Mr. F. O. Dufour comes to Lafayette this year as Simon Cameron Long professor of civil engineering. Professor Dufour was in charge of construction work for Stone and Webster and has had much teaching experience, also, at the University of Illinois and Lehigh University.

Morland King, who came to Lafayette last year from Union College as associate professor of electrical engineering, has been made professor and head of the Electrical Engineering Department.

The course in engineering problems for freshmen, which has been given successfully for several years, will be continued, the classes being taught by the senior professors in the engineering departments. The engineering student is thus brought into immediate contact with applications of his elementary mathematics and science and secures the early guidance of men of considerable teaching and practical experience.

Student branches of four of the National Engineering societies have organized for the year and the local chapter of Tau Beta Pi has held its fall initiation.

PERSONALS.

H. S. Jacoby, president of the Society in 1915–16, has resigned from the faculty of Cornell University, with which he has been connected 31 years; for 21 years as full professor and head of the Department of Bridge Engineering. Professor Jacoby will retire at the close of the college year next June, having reached the age specified for retirement.

Dr. K. G. Matheson has resigned the presidency of Georgia School of Technology to accept the position of President of Drexel Institute to take effect on April 1, 1922. Dr. Matheson has been president of Georgia Tech. for eighteen years and during that time has built it up from a prep school to a splendid technical school of the first rank. His loss will be keenly felt in educational circles of the south.